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Kuroki et al.

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(54) **CONNECTOR WITH SHORT INTERVAL ARRANGEMENTS OF CONTACTS**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**[7] **H01R 13/40**
(52) **U.S. Cl.** **439/733.1**; 439/752; 439/595; 439/603
(58) **Field of Search** 439/733.1, 752, 439/595, 603

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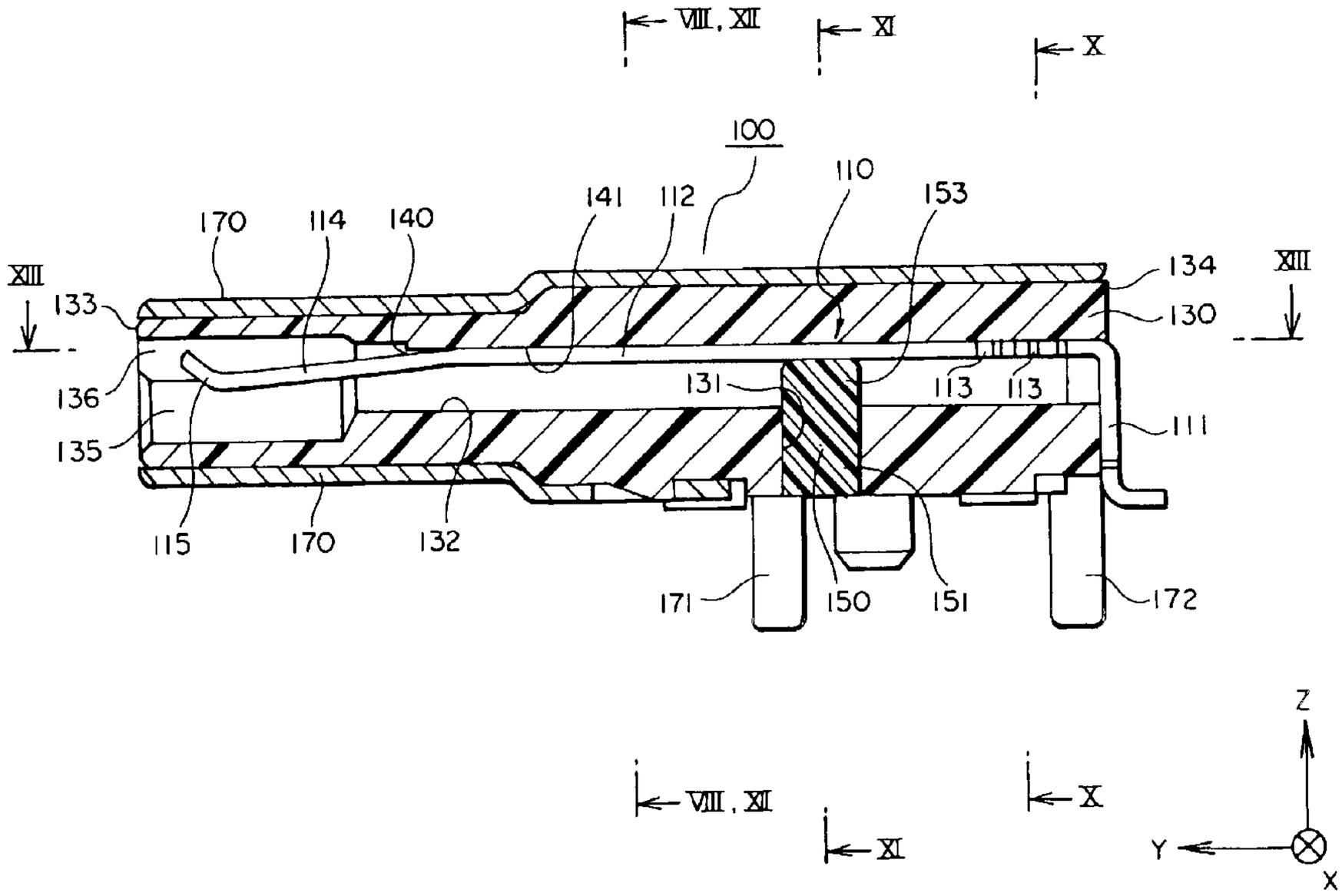
(74) *Attorney, Agent, or Firm*—Collard & Roe, P.C.

(57) **ABSTRACT**

A connector comprises contact pins, an insulator and a supplementary insulator. Each of the contact pins comprises a supported portion and a contact end. The insulator comprises accommodation portions which accommodate the respective contact pins. Each of the accommodation portions is provided with a supporting portion which includes a supporting surface and supports the supported portion of the corresponding contact pin. The supplementary insulator is fixedly held by the insulator. At least one part of the supported portion of the contact pin is placed between the supporting surface and the supplementary insulator in a Z-direction. Therefore, the supported portion always straightly extends in a Y-direction so that the contact end can be surely positioned at a predetermined position.

11 Claims, 14 Drawing Sheets



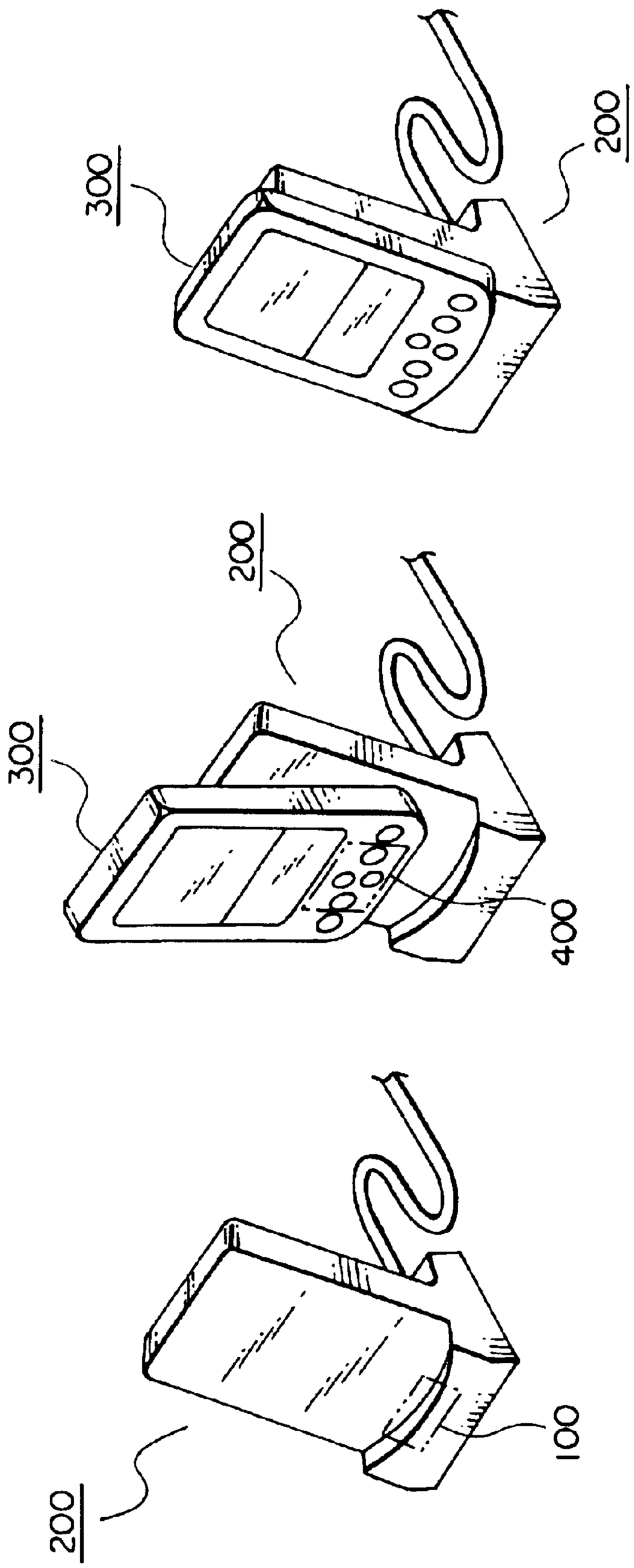


FIG. 1

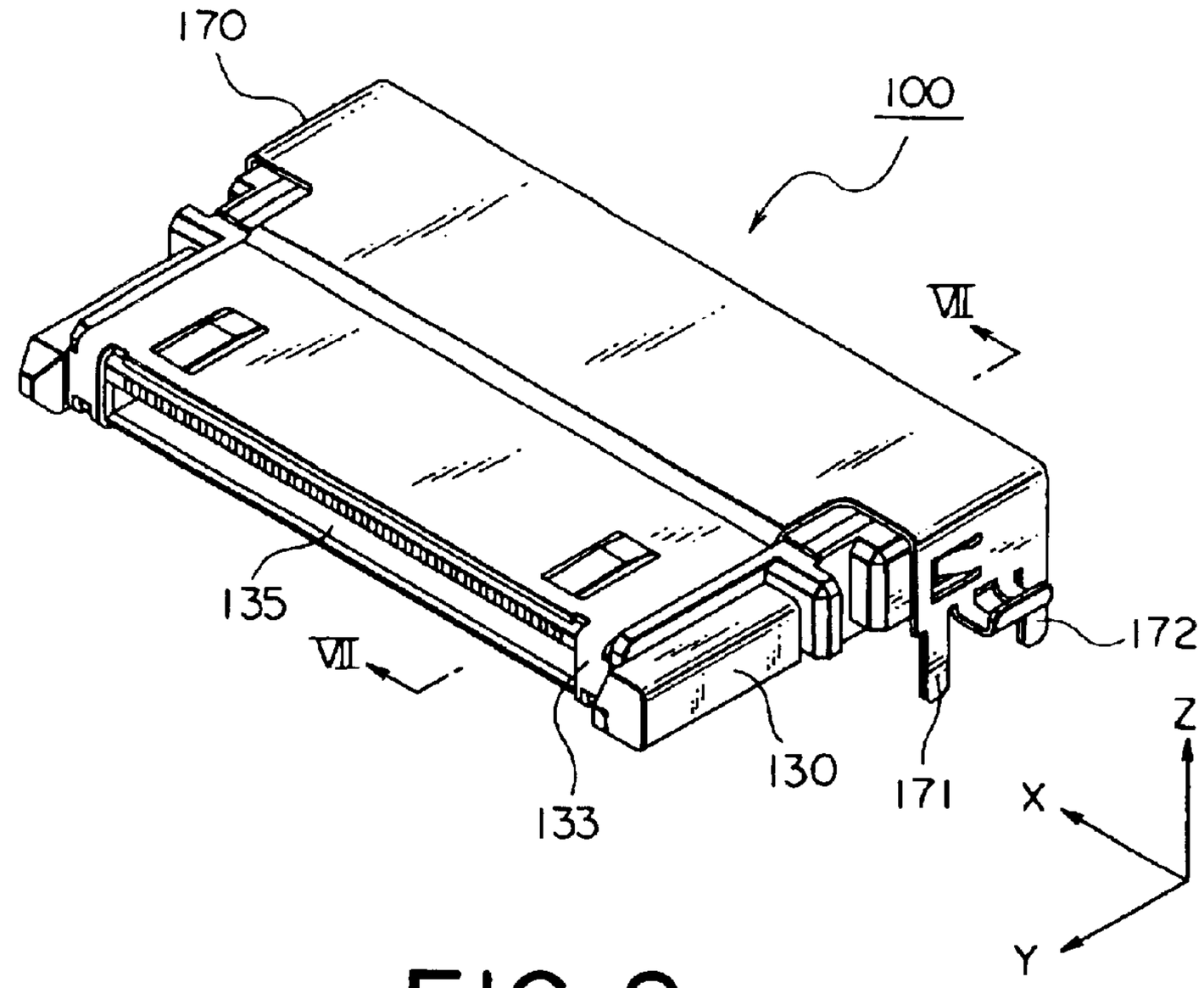
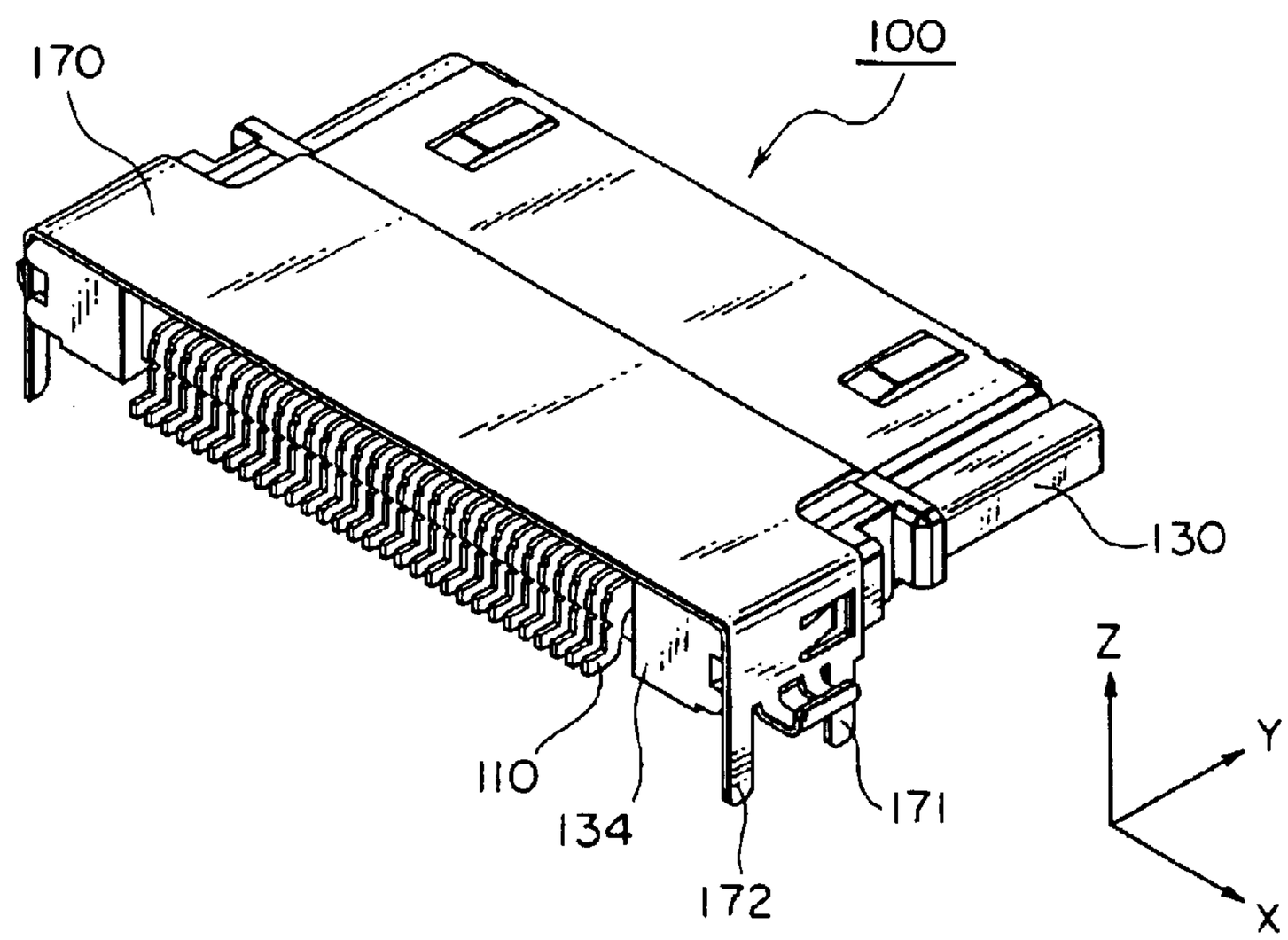

170
100
VII
135
VII
172
130
171
133
Z
X
Y

FIG. 2


170
100
130
110
134
172
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Z
Y
X

FIG. 3

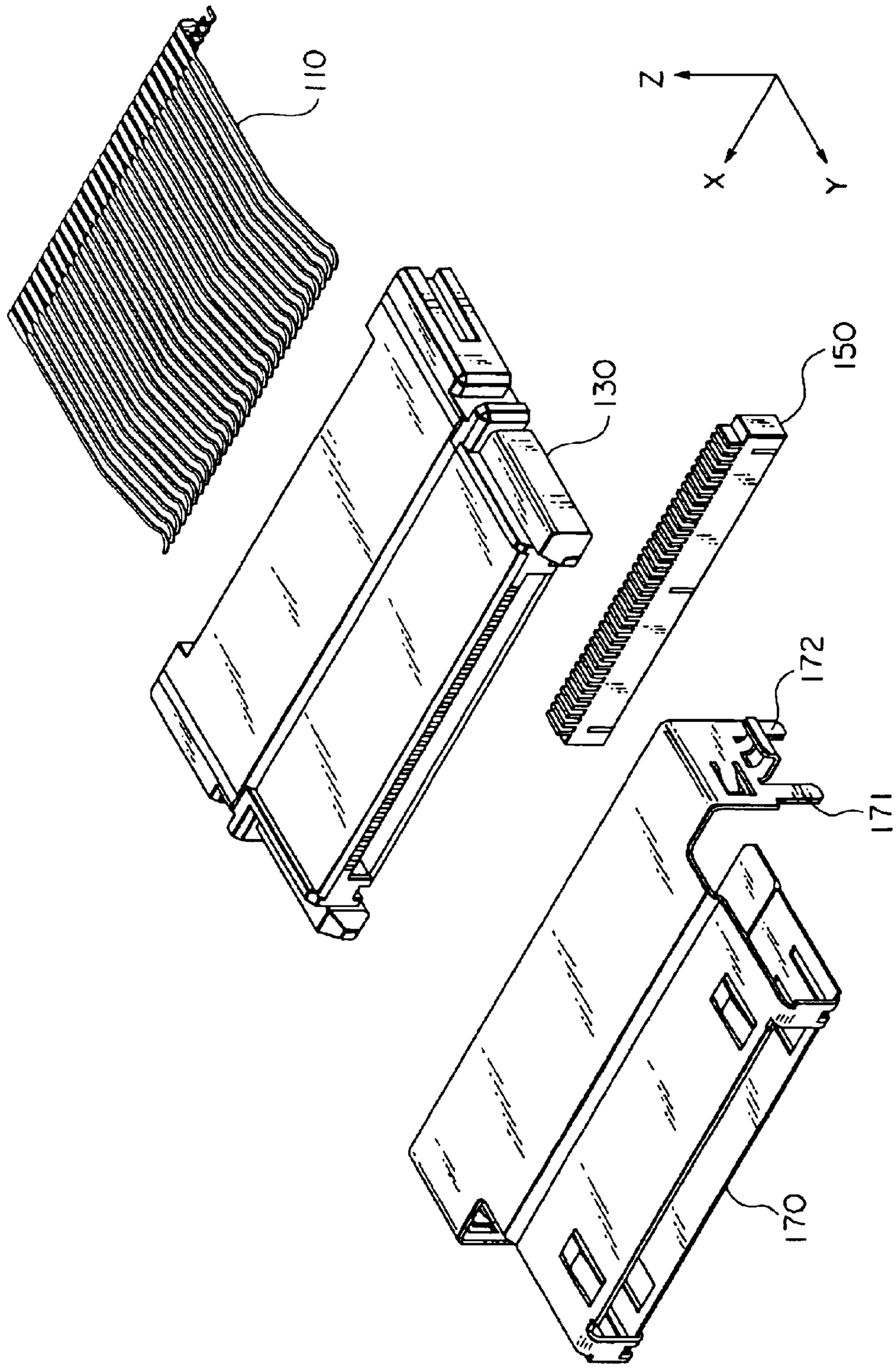
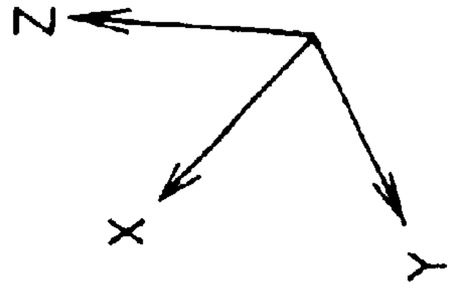


FIG. 4



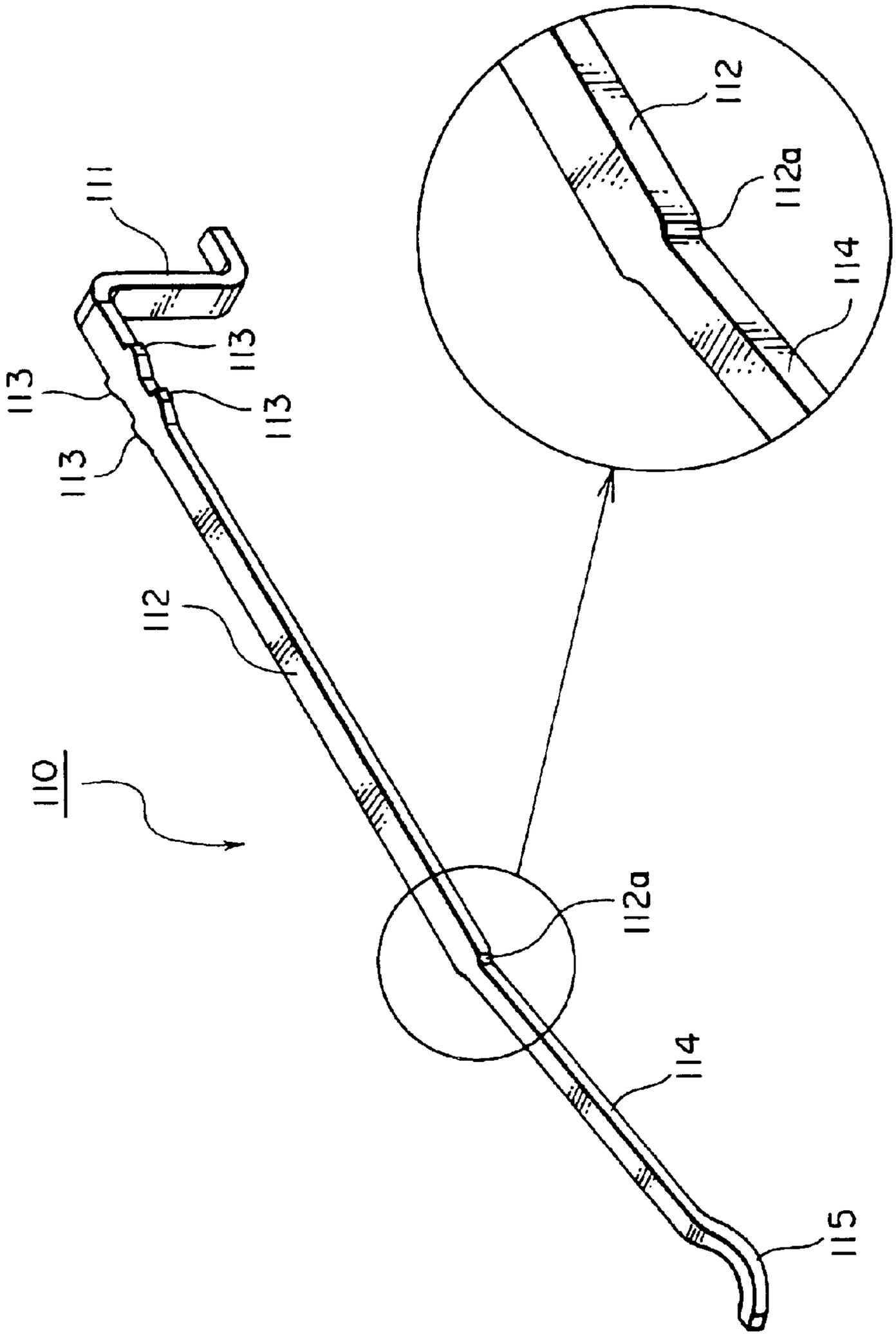


FIG. 5

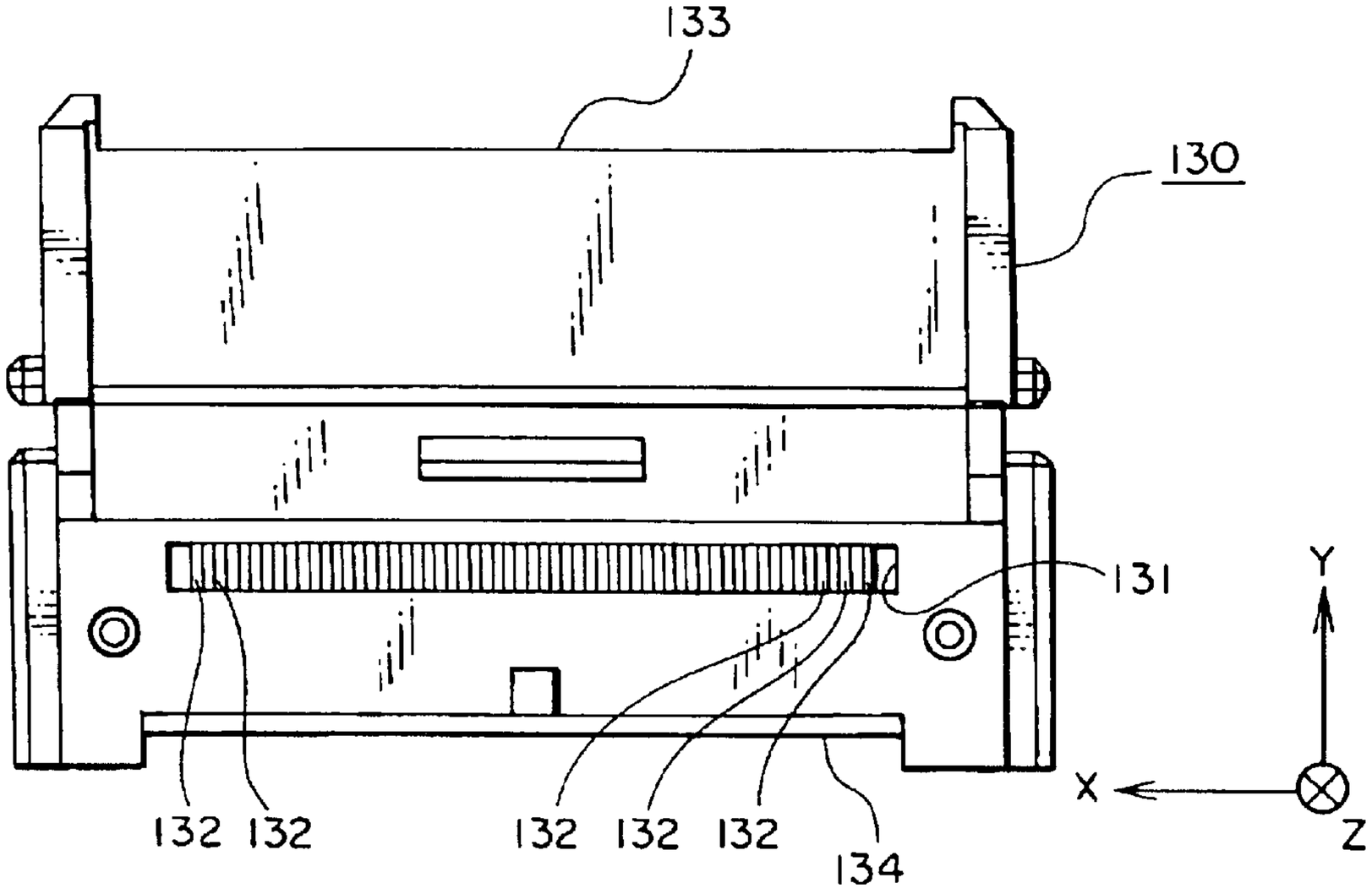


FIG. 6

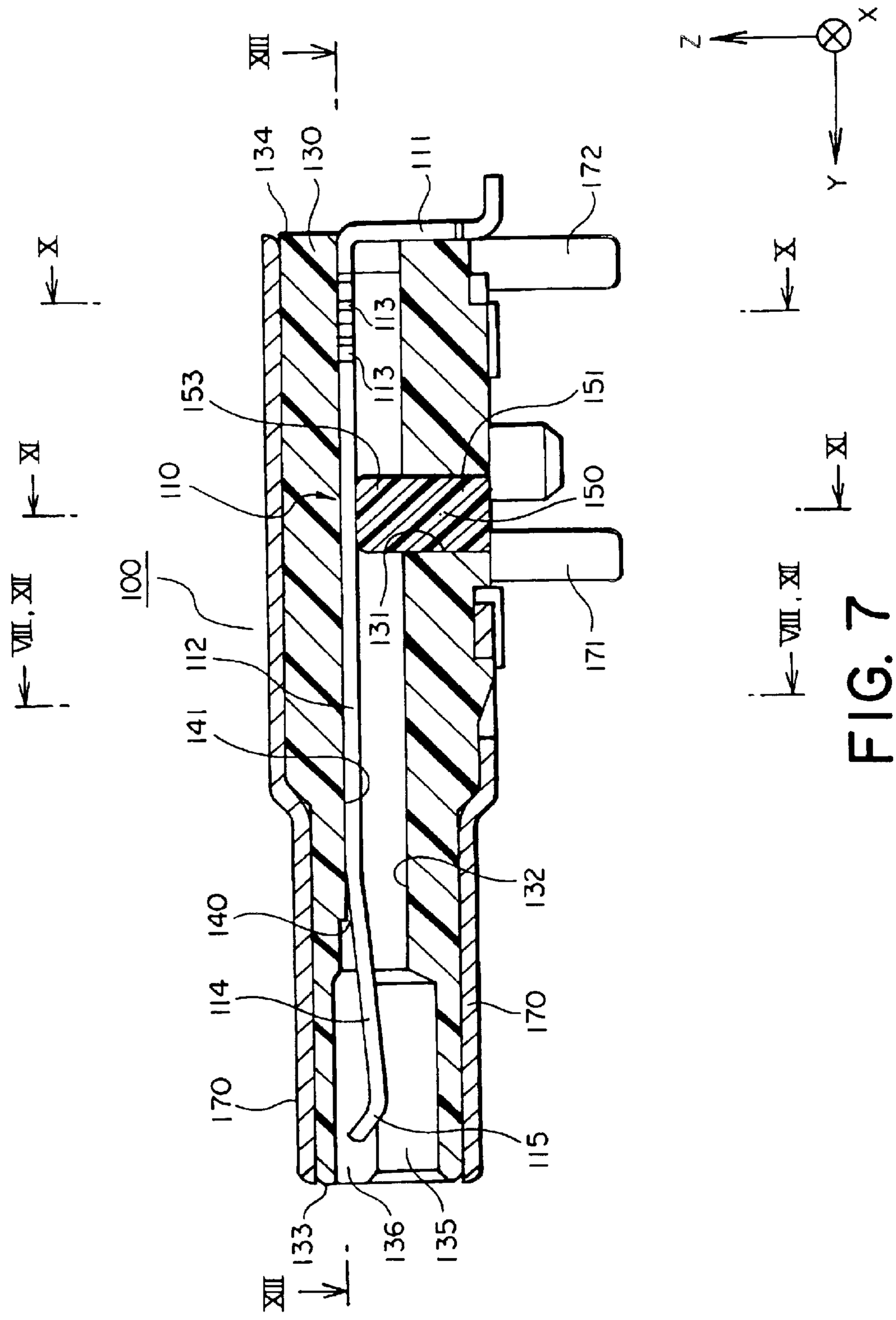

Z
X
Y
XIII
134
130
111
172
113
113
153
151
110
150
100
131
171
112
141
132
140
114
170
170
115
133
136
135
XIII
X
XI
VIII, XII
X
XI
VIII, XII

FIG. 7

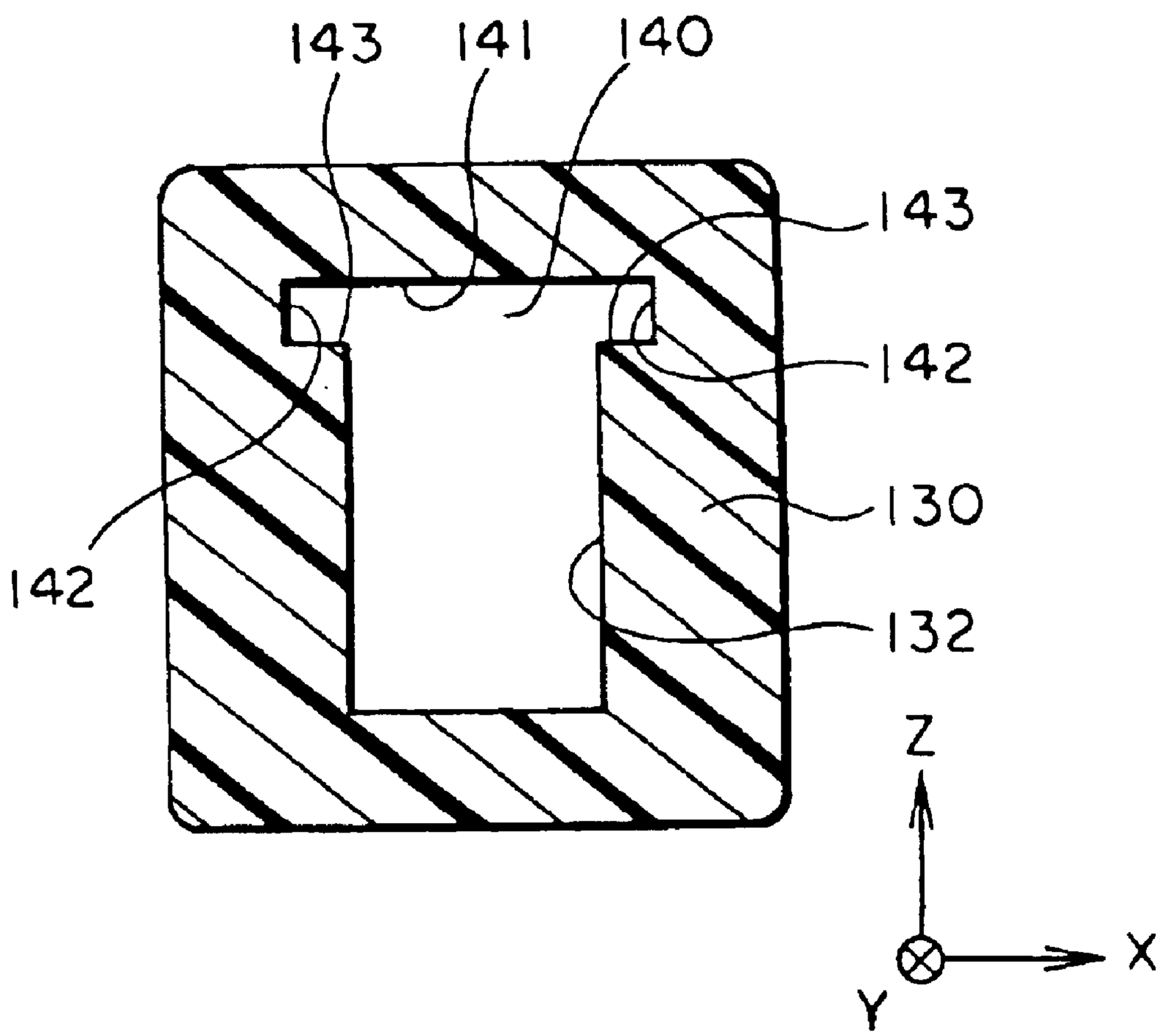
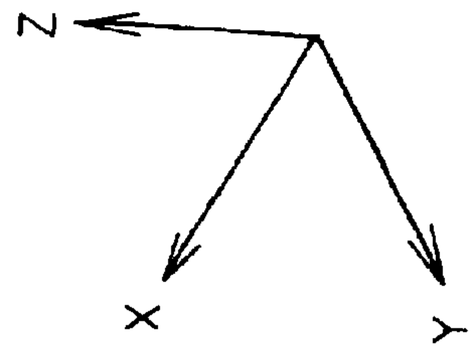


FIG. 8



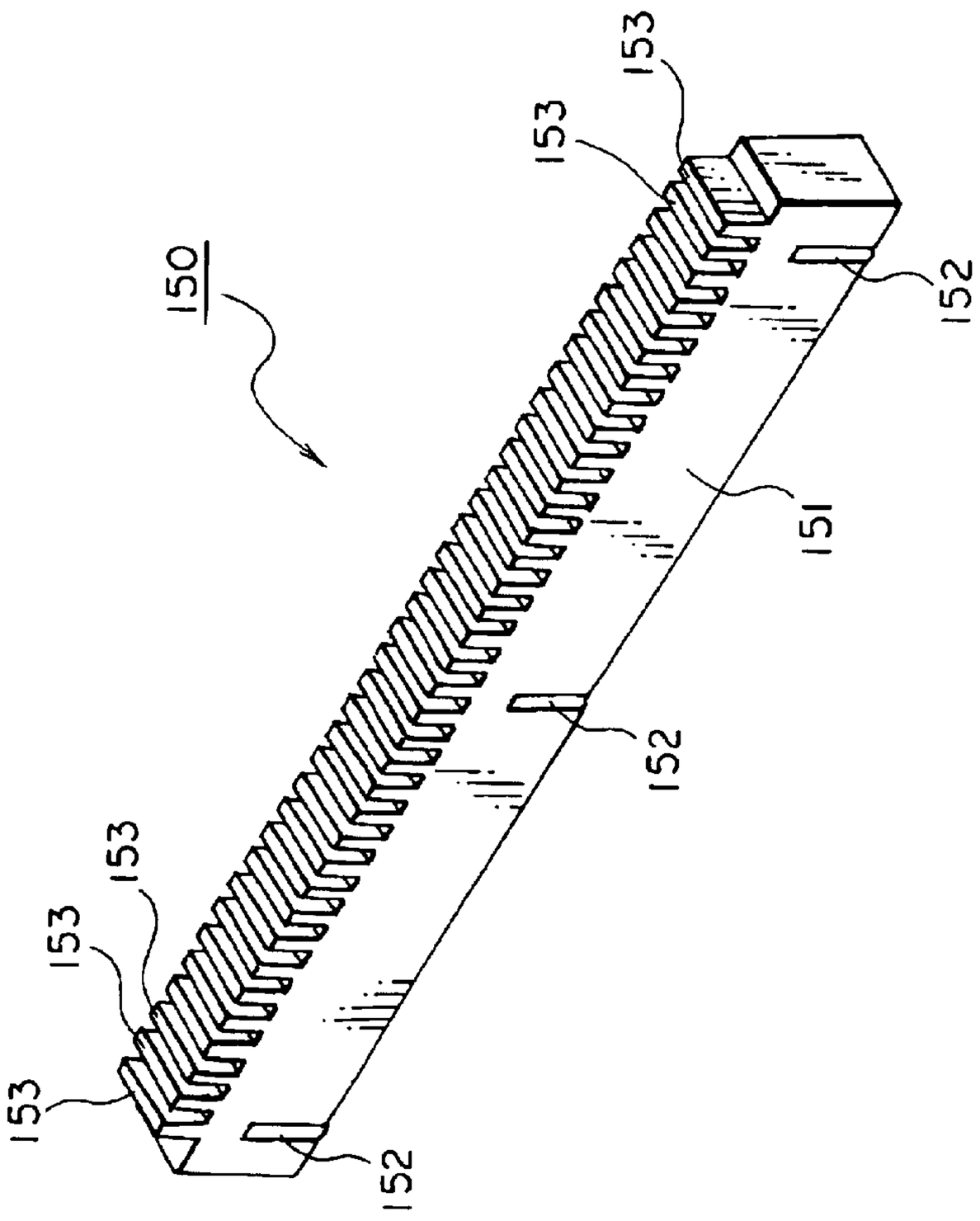


FIG. 9

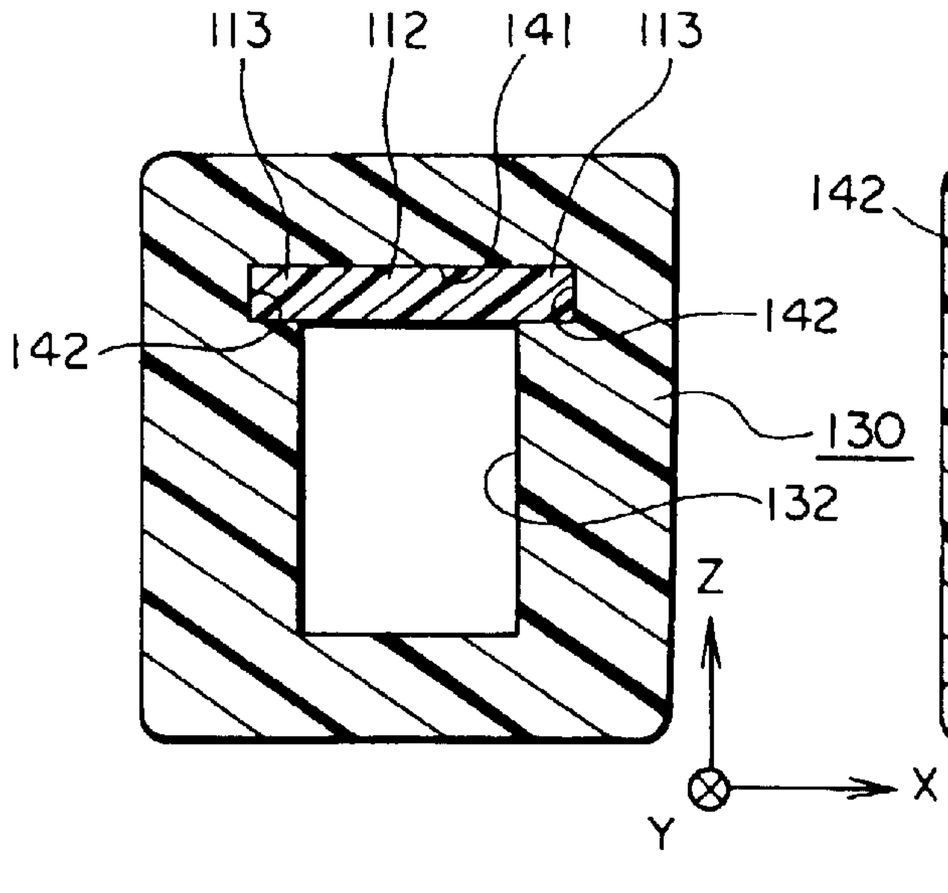


FIG. 10

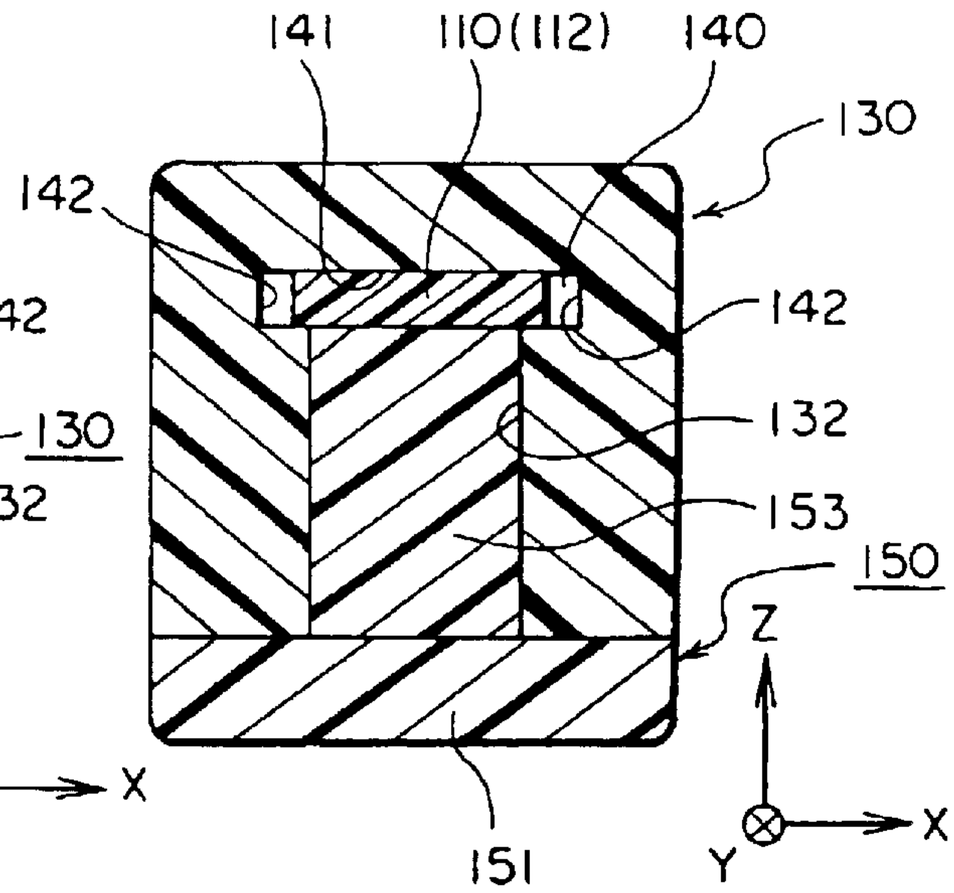


FIG. 11

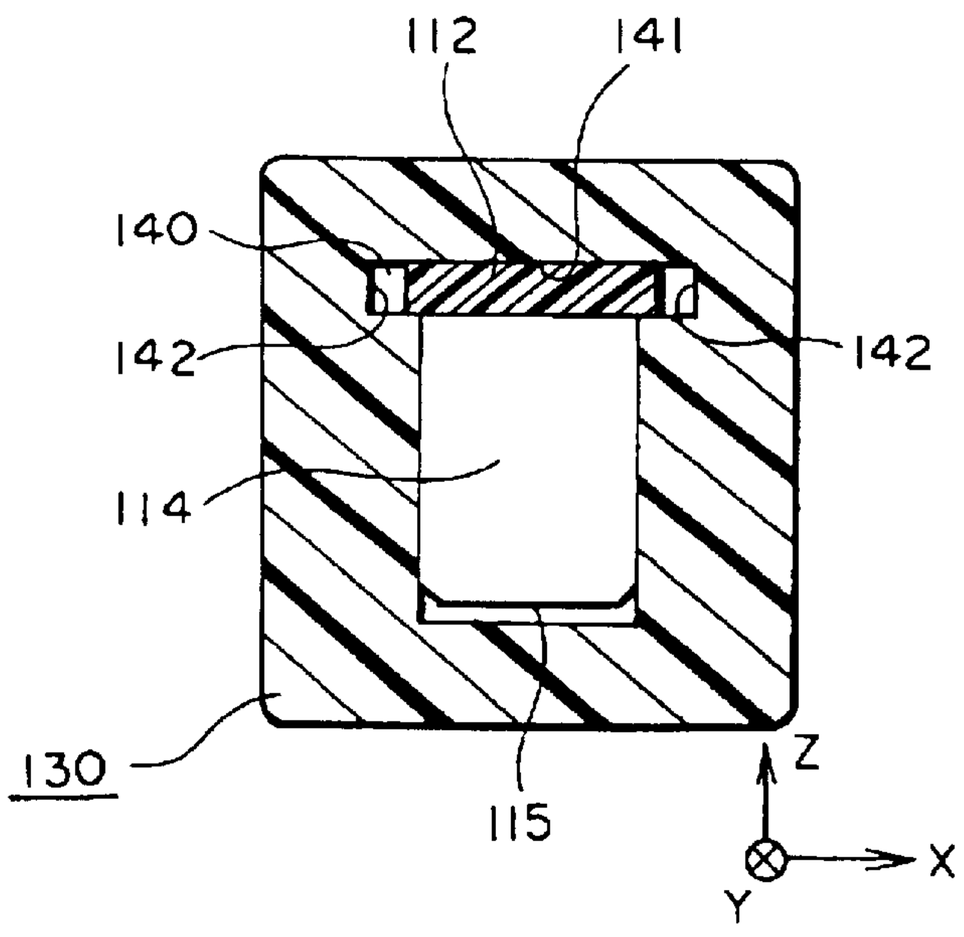
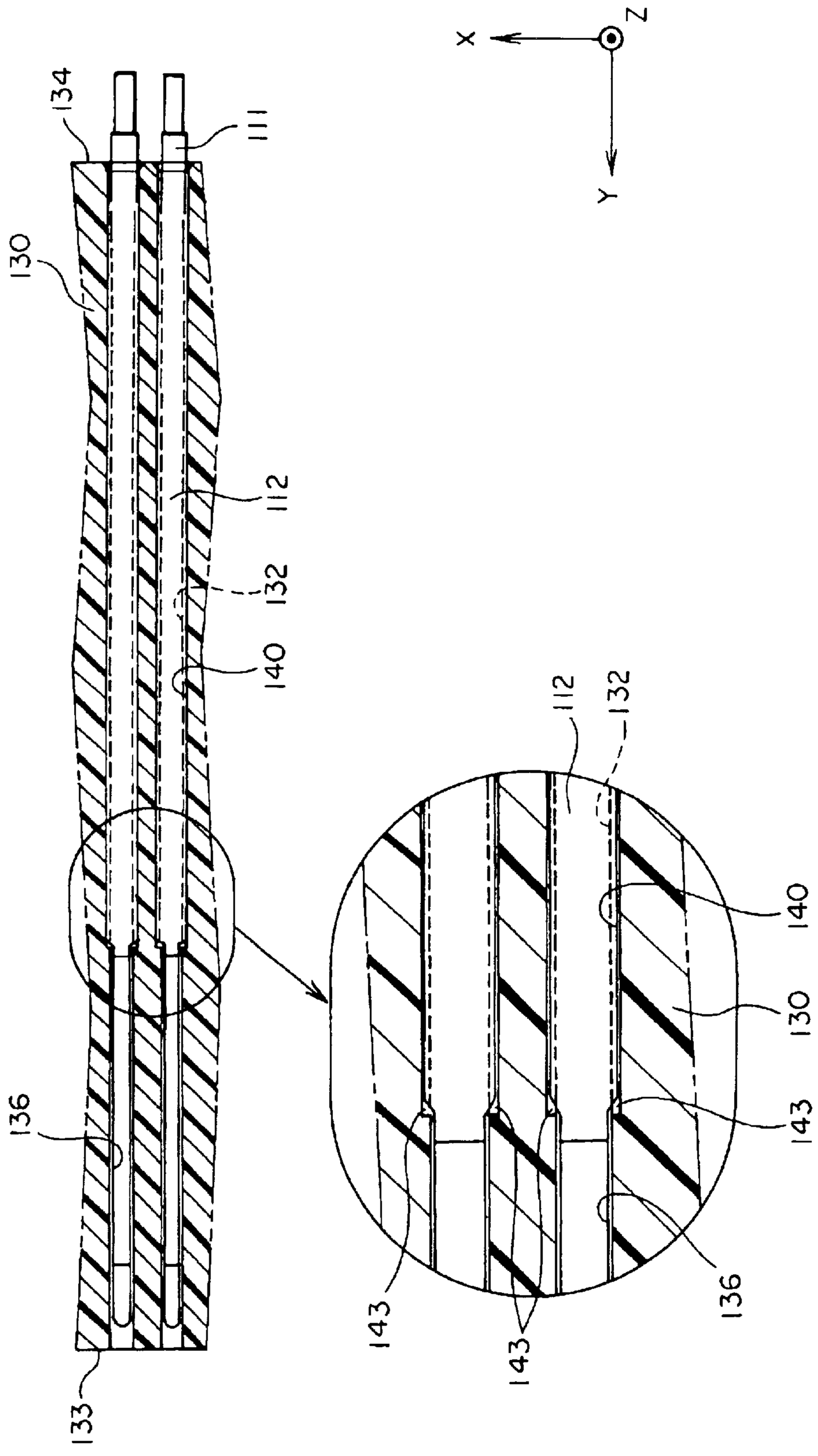


FIG. 12


X
Z
Y
134
111
130
112
132
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112
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143
136

FIG. 13

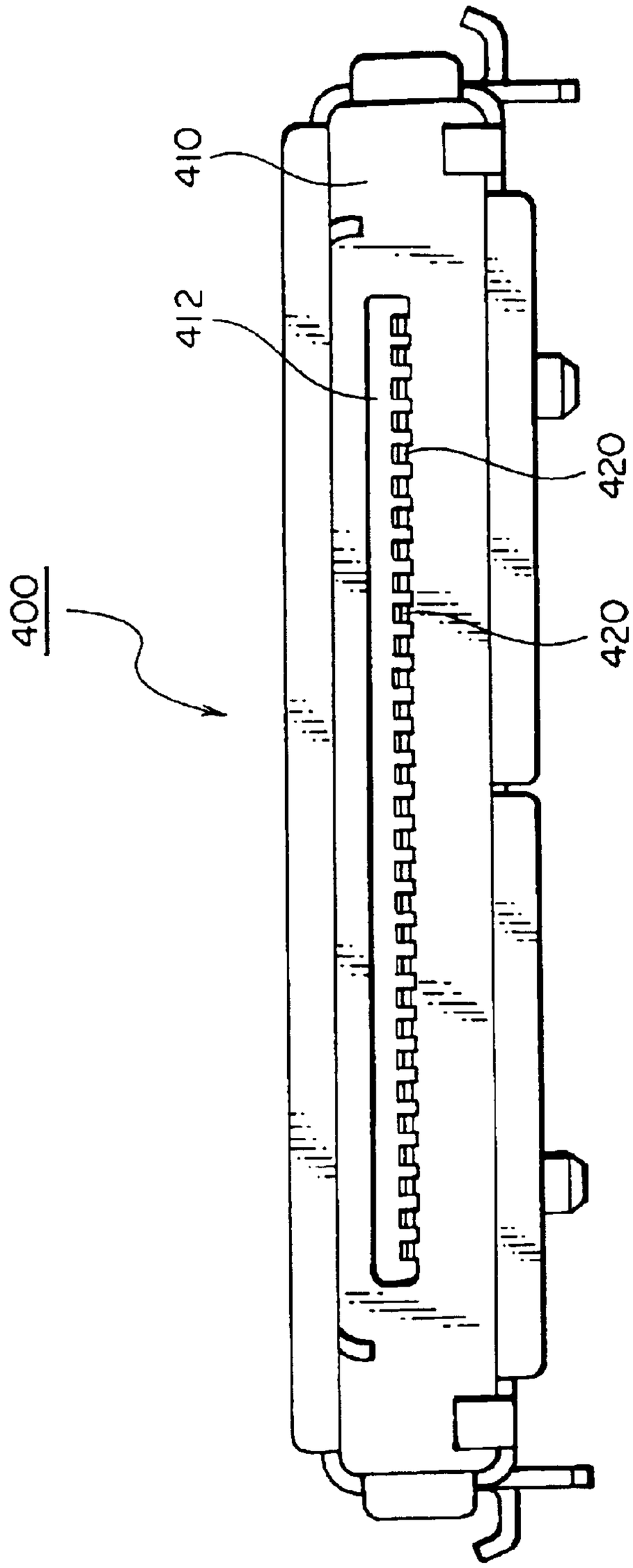
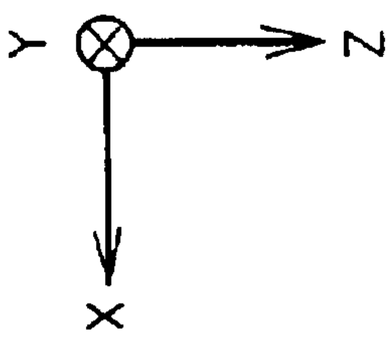


FIG. 14



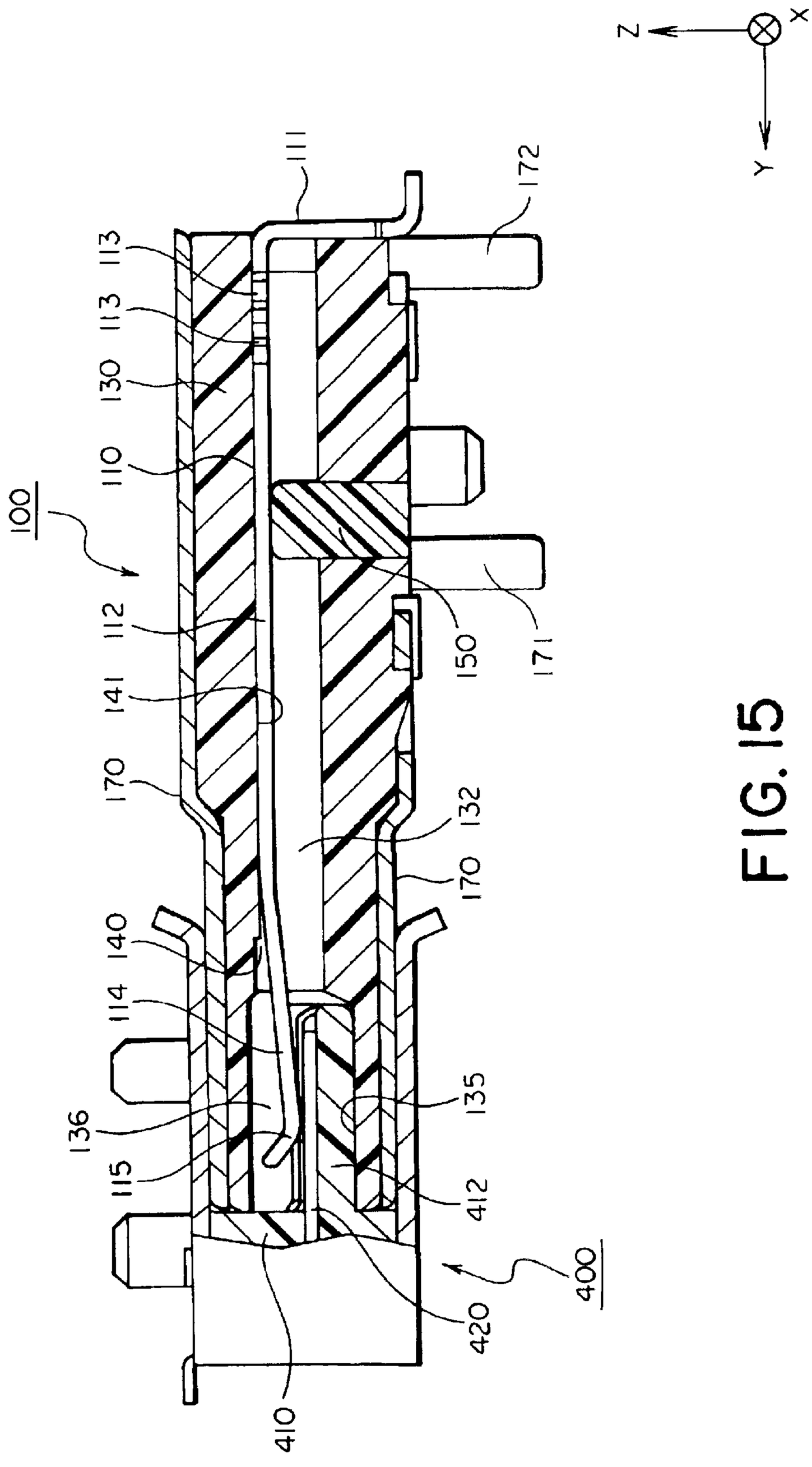

Z
X
Y
111
172
113
113
130
110
100
112
141
170
150
171
132
170
140
114
136
135
115
412
420
400
410

FIG. 15

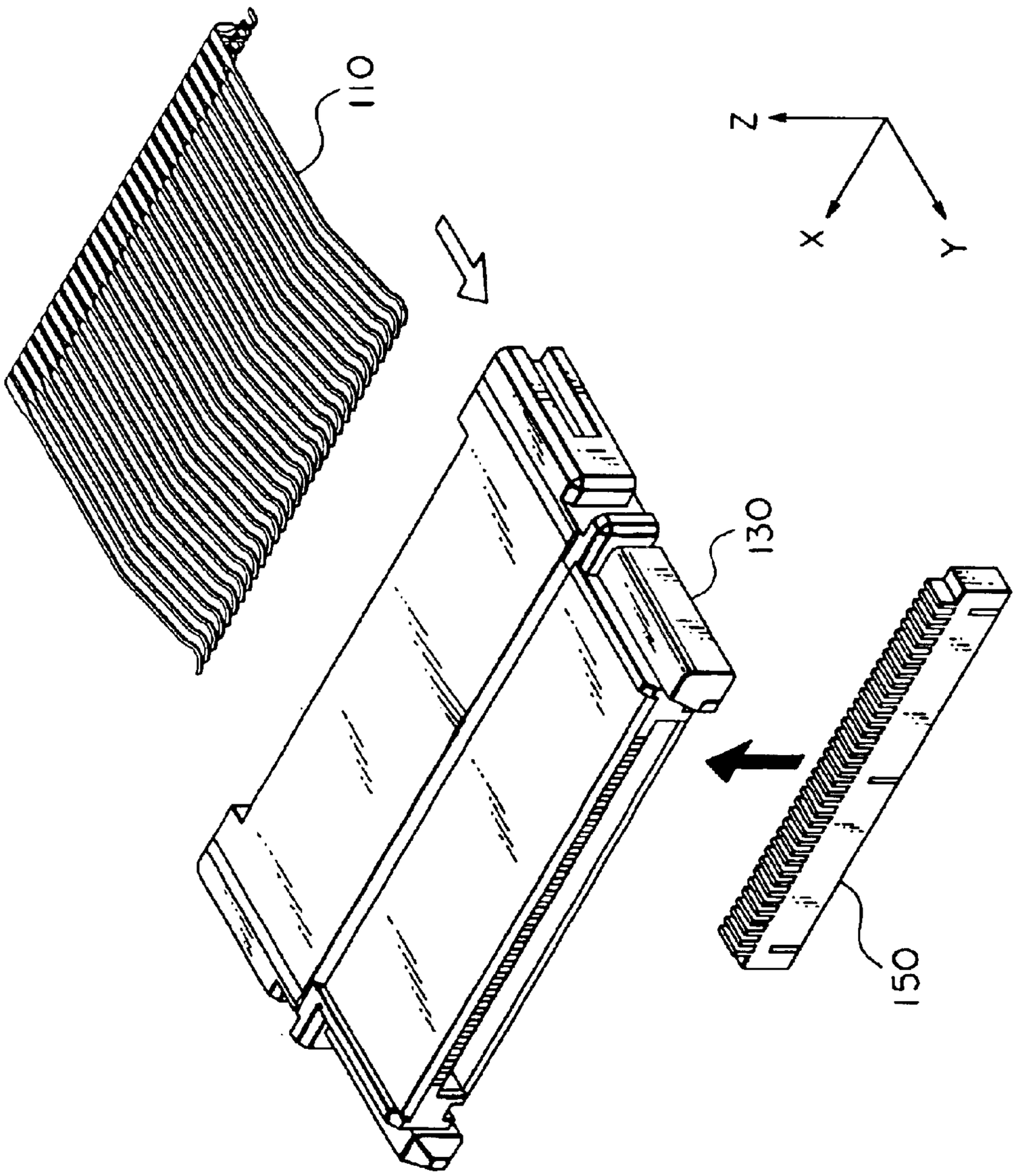
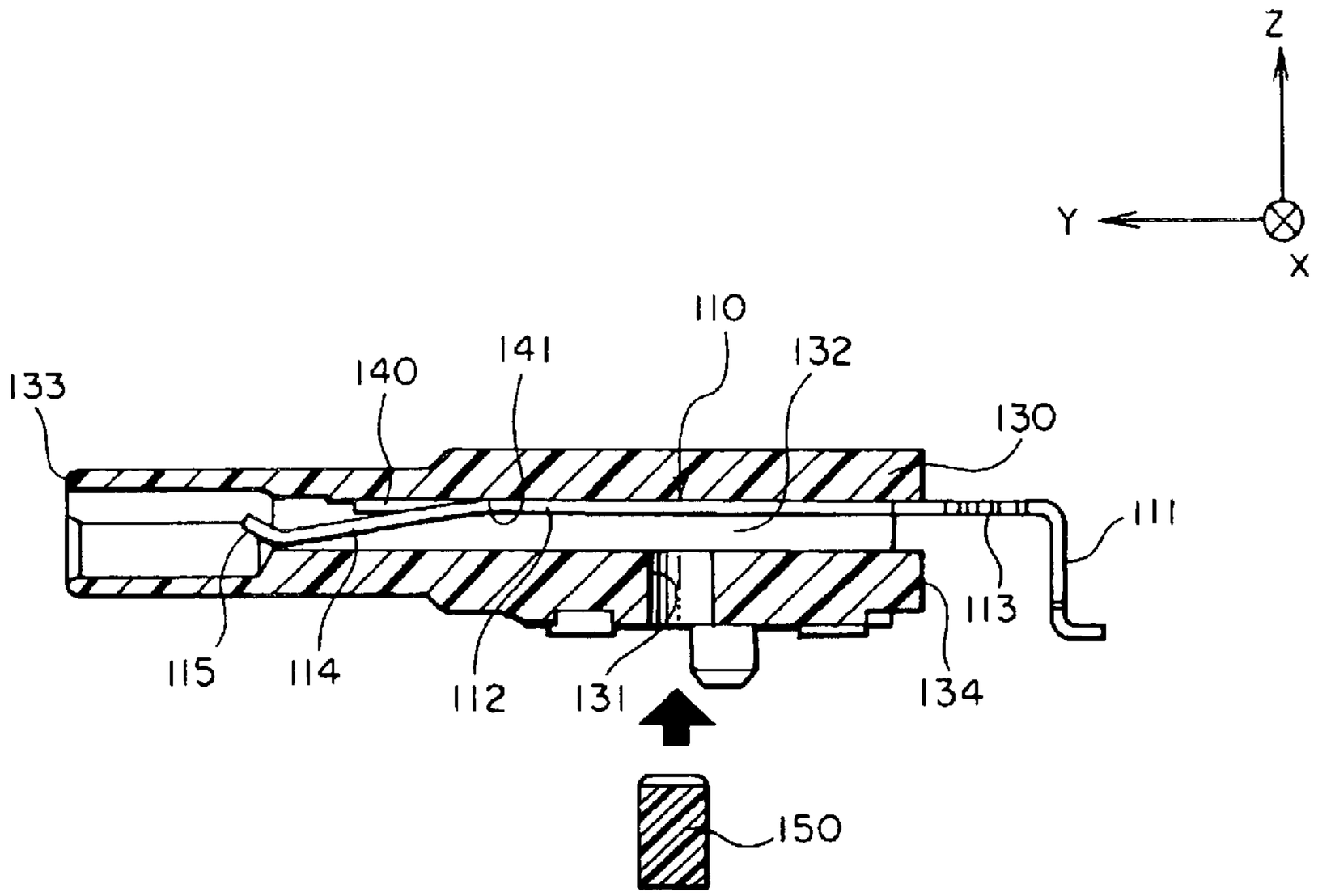


FIG. 16


Z
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141
140
133
130
111
113
115
114
112
131
134
150

FIG. 17

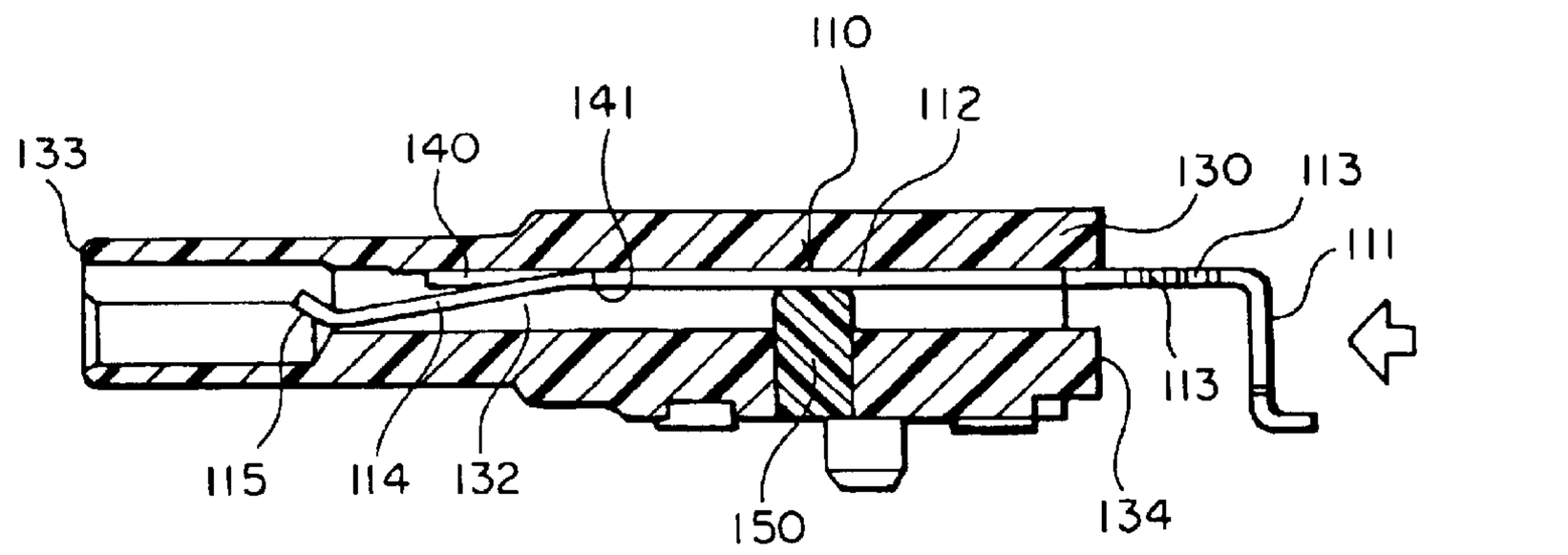
110
141
112
140
133
130
113
111
115
114
132
150
134
Z
Y
X

FIG. 18

CONNECTOR WITH SHORT INTERVAL ARRANGEMENTS OF CONTACTS

This application claims priority to prior Japanese patent application JP 2002-317106, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION:

This invention relates to a connector which comprises a plurality of contact pins held by an insulator and arranged at short intervals in the insulator.

Each contact pin is comprised of a supported portion extending straightly, a contact end and a connecting portion connecting the supported portion and the contact end. The supported portion has a flat narrow plate like shape. The connecting portion extends from the supported portion in a direction oblique to the extending direction of the supported portion. The insulator is formed with accommodation portions. The supported portion is supported by the corresponding accommodation portion. In detail, each accommodation portion has a T-like shaped cross-section in a plane perpendicular to the extending direction of the supported portion. The wider part of the accommodation portion holds and supports the supported portion. With the above-mentioned structure, the position of the contact end depends on the position of the supported portion. In other words, depending on whether the supported portion is surely and suitably supported by the accommodation portion, the position of the contact end of the contact pin is determined.

The short interval arrangements of the contact pins cause one problem as to the positioning of the contact ends. Even if the interval or pitch between the neighboring contact pins becomes shorter, the width of the contact ends should be kept unchanged or be changed with a very small change, as well as the wall thickness between the neighboring accommodation portions because of electrical and mechanical requirements. Therefore, as the interval between the neighboring contact pins becomes shorter, the width of the neighboring supported portions should become narrower as well as the corresponding part of the accommodation portion. As a result, it is difficult that the supported portion is surely supported by the accommodation portion of the insulator.

Thus, there is a need for a connector which can surely support the supported portion of each contact pin by the insulator so that the contact end of the contact pin is positioned at its suitable position.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a connector which can surely support contact pins and can arrange their ends at their suitable positions.

According to the present invention, there is provided a connector comprising a plurality of contact pins; an insulator supporting the contact pins in a state arranged in a first direction. Each of the contact pins comprises a supported portion which extends in a second direction perpendicular to the first direction. The insulator comprises a plurality of accommodation portions which accommodate the respective contact pins. Each of the accommodation portions is provided with a supporting portion which supports the supported portion of the corresponding contact pin. The supporting portion includes a supporting surface which receives the supported portion of the corresponding contact pin in a third direction perpendicular to the first and the second directions. The connector further comprises a supplementary insulator fixedly held by the insulator and pushing at least

one part of the supported portion of each of the contact pins to the supporting surface to hold the at least one part of the supported portion between the supporting surface and the supplementary insulator.

Preferred developments of the invention are defined in the dependent claims and the method claim thereof.

BRIEF DESCRIPTION OF THE DRAWINGS:

FIG. **1** is a schematic view showing an overview of an application use of a connector according to one embodiment of the present invention;

FIG. **2** is a front oblique view showing the connector of FIG. **1**;

FIG. **3** is a rear oblique view showing the connector of FIG. **2**;

FIG. **4** is an exploded, perspective view showing the connector of FIG. **2**;

FIG. **5** is a perspective view showing a contact pin included in the connector of FIG. **2**;

FIG. **6** is a bottom view showing an insulator included in the connector of FIG. **2**;

FIG. **7** is a cross-sectional view showing the connector of FIG. **2**, taken along lines VII—VII;

FIG. **8** is a partial, cross-sectional view showing the connector of FIG. **7**, taken along lines VIII—VIII;

FIG. **9** is a perspective view showing a supplementary insulator included in the connector of FIG. **2**;

FIG. **10** is a partial, cross-sectional view showing the connector of FIG. **7**, taken along lines X—X;

FIG. **11** is a partial, cross-sectional view showing the connector of FIG. **7**, taken along lines XI—XI;

FIG. **12** is a partial, cross-sectional view showing the connector of FIG. **7**, taken along lines XII—XII;

FIG. **13** is a partial, cross-sectional view showing the connector of FIG. **7**, taken along lines XIII—XIII;

FIG. **14** is a front view showing a mating connector which is to be mated with the connector of FIG. **2**;

FIG. **15** is a cross-sectional view showing the connector of FIG. **2** and the mating connector of FIG. **14** under the mated state;

FIG. **16** is a perspective view showing a fabrication method of the connector of FIG. **2**;

FIG. **17** is a cross-sectional view showing a process of the fabrication method shown with a black arrow in FIG. **16**; and

FIG. **18** is a cross-sectional view showing another process of the fabrication method shown with a hollow or white arrow in FIG. **16**.

DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to FIG. **1**, a connector **100** according to one embodiment of the present invention is installed into a cradle **200** for a personal data assistant (PDA) or a mobile intelligent terminal **300**. The PDA **300** comprises a connector **400** as a mating connector of the connector **100**. When the PDA **300** is put on the cradle **200**, the connector **100** is mated with the mating connector **400**.

With reference to FIGS. **2** to **4** and FIG. **7**, the connector **100** comprises a plurality of contact pins **110**, an insulator **130**, a supplementary insulator **150** and a shell **170**. The insulator **130** holds the contact pins **110** in cooperation with the supplementary insulator **150** so that the contact pins **110**

are arranged in an X-direction. The shell **170** covers the insulator **130** as well as the contacts **110** and the supplementary insulator **150**.

With reference to FIG. **5**, each contact pin **110** is comprised of a terminal end **111**, a supported portion **112** formed with press-fit portions **113**, a connecting portion **114**, and a contact end **115**. The terminal end **111** has an L-like shape and is to be connected to a signal line or a ground line of a circuit provided in the cradle **200**. The supported portion **112** straightly extends from the terminal end **111** so that the supported portion **112** and the terminal end **111** make an almost right angle. The supported portion **112** has a flat narrow plate like shape. As shown in FIG. **7**, the extending direction of the supported portion **112** is a Y-direction under the assembled state of the connector **100**. As shown in FIG. **5**, each press-fit portion **113** has a barb like shape and projects from the corresponding side edge of the supported portion **112** in a direction perpendicular to the extending direction of the supported portion **112**. In other words, the press-fit portion **113** projects in the X-direction under the assembled state. The position of the press-fit portion **113** is nearer to the terminal end **111** than to the contact end **115**. From an end of the supported portion **112** opposite to the end connected to the terminal end **111**, the connecting portion **114** extends in a direction oblique to the extending direction of the supported portion and the projecting direction of the press-fit portion. The connecting portion **114** connects the supported portion **112** and the contact end **115**. The contact end **115** is a flared free end of the contact pin **110**. The contact end **115** and the connecting portion **114** have a width narrower than the supported portion **112** so that the contact pin **110** has shoulder portions **112***a* as shown in an enlarged circle of FIG. **5**.

With reference to FIGS. **6** to **8**, the insulator **130** has a hole **131** and a plurality of accommodation portions **132**. The hole **131** extends in the X-direction and communicates between the bottom surface of the insulator **130** and the accommodation portions **132**. The accommodation portions **132** extend in the Y-direction and are arranged in the X-direction.

As shown in FIG. **7**, the insulator **130** has a front end **133** and a rear end **134** in the Y-direction. The front end **133** of the insulator **130** is an open end and is provided with a receiving portion **135** and a plurality of recesses **136** so that the front end **133** serves as an interface with the mating connector **400**, as shown in FIG. **15**. The recesses **136** serve to receive the respective contact ends **115** upon the mating of the connector **100** with the mating connector **400**. As shown in FIG. **7**, the accommodation portion **132** extends from the rear end **134** of the insulator **130** to the receiving portion **135** and the corresponding recess **136**.

As shown in FIG. **8**, the accommodation portion **132** generally has a T-like shaped cross-section, except for its part directly connected to the hole **131**. The wider part of the T-like shaped cross-section is a supporting portion **140** which supports the supported portion **112** of the contact pin **110**. The supporting portion **140** has a supporting surface **141**, which is perpendicular to a Z-direction. The supporting portion **140** also has sidewalls **142**, in which the press-fit portions **113** are engaged upon the fitting of the contact pins **110** to the insulator **130**. Because the supporting portion **140** is the wider part of the accommodation portion **132**, the sidewalls **142** are different, in the X-direction, from sidewalls of the other portion of the accommodation portion **132** so that there are steps **143** between the supporting portion **140** and the other portion of the accommodation portion **132**. The supporting surface **141** and the steps **143** receive the supported portion **112** of the contact pin **110** so that the supported portion **112** is supported.

As shown in FIG. **13**, the supporting portion **140** is wider than the corresponding recess **136** in the X-direction, while the other portion of the accommodation portion **132** is substantially equal in size to the recess **136** in the X-direction. Basically, with the structure, the shoulder portions **112***a* of the contact pin **110** are prevented from going beyond the boundary between the supporting portion **140** and the recess **136** towards the recess **136**. The connecting portion **114** and the contact end **115** are accommodated in the receiving portion **135** of the insulator **130**.

As mentioned above, the short interval arrangements of the contact pins cause the sizes of the steps **143** to become small. Also, they cause the width of the supported portion **112** of each contact pin **110** to become small. Therefore, it becomes difficult to surely support the supported portion **112** by using only the supporting portion **140** of the insulator **130**. To assist the support, the connector **100** according to the present embodiment uses the supplementary insulator **150**.

With reference to FIG. **9**, the supplementary insulator **150** is comprised of a base portion **151**, a plurality of protrusions **152** and a plurality of pressing portions **153**. The base portion **151** is generally a rectangular parallelepiped and extends in the X-direction. The protrusions **152** are dowels in this embodiment and are bulged in the Y-direction. Upon the fitting of the supplementary insulator **150** to the insulator **130**, the protrusions **152** are engaged in the inner wall of the hole **131** of the insulator **130** to fix the base portion **151** of the supplementary insulator **150** into the hole **131** of the insulator **130**. The protrusions **152** may be simply removed, and another fixing means may be adopted instead of the protrusions **152**.

The pressing portions **153** are arranged in the X-direction. Each of the pressing portions **153** has a flat plate like shape and extends from the base portion **151** in the Z-direction. As seen from FIG. **7**, when the base portion **151** is fixedly fitted within the hole **131** of the insulator **130**, the pressing portions **153** are inserted into the respective accommodation portions **132** to press the respective supported portion **112** against the respective supporting surfaces **141**. In other words, each of the supported portions **112** is partially placed between the corresponding pressing portion **153** and the corresponding supporting surface **141** in the Z-direction, as best shown in FIGS. **7** and **11**.

In this embodiment, the supplementary insulator **150** is positioned nearer to the front end **133** of the insulator **130** than the press-fit portions **113** of the contact pins **110**. As seen from FIGS. **10** to **12**, all of the supported portions **112** are surely supported by the respective supporting portions **140**. The connecting portions **114** substantially extend in the same direction as each other. Therefore, the contact ends **115** are positioned on the same level as each other. The arrangements of the contact ends **115** make a contribution to reliable electrical connections between the contact pins **110** and other contact pins of the mating connector **400**. The supplementary insulator **150** may be positioned around the press-fit portions **113**. Also, the supplementary insulator **150** may be positioned nearer to the receiving portion **135** than the present embodiment illustrated in FIG. **7**.

The shell **170** covers the insulator **130** holding the contact pins **110** and the supplementary insulator **150**, except for the front and the rear ends **133**, **134** of the insulator **130** and a part of the bottom surface of the insulator **130**. The shell **170** is provided with mounting posts **171**, **172**, which extend

beyond the bottom surface of the insulator **130** in the Z-direction. The mounting posts **171**, **172** serve to fix the connector **100** to a substrate (not shown) provided within the cradle **200**. With this structure, the shell **170** electrically shields the connector **100** from noises.

With reference to FIGS. **14** and **15**, the mating connector **400** has another insulator **410** and another set of contact pins **420**. In detail, the insulator **410** has a flat plate like shaped projection **412**, which serves as a fitting portion to the connector **100** and is received within the receiving portion **135** of the connector **100**, as shown in FIG. **15**. The contact pins **420** are arranged in one surface of the projection **412**. Specifically, the contact pins **420** are accommodated in grooves, respectively, which are formed in the surface of the projection **412**. As shown in FIG. **15**, when the connector **100** is mated with the mating connector **400**, the contact end **115** is brought into contact with the corresponding contact **420**, while being pressed in the Z-direction so that the corresponding recess **136** accommodates the contact end **115**.

With reference to FIGS. **16** to **18**, the fabrication method of the connector **100** will be explained now.

The contact pins **110** are tentatively inserted into the respective accommodation portions **132** from the rear end **134** towards the front end **133** along the Y-direction. However, the press-fit portions **133** are still not inserted into the respective accommodation portions **132**, as shown in FIG. **17**.

Under the state, the supplementary insulator **150** is fitted within the insulator **130** so that the supported portions are partially placed between the supplementary insulator **150** and the respective supporting surfaces **141**, as shown in FIG. **18**. In other words, the supplementary insulator **150** is inserted into the insulator **130** along the Z-direction so that the supplementary insulator **150** presses the supported portions **112** against the respective supporting surfaces **141**.

Then, the contact pins **110** are further pressed into the respective accommodation portions **132** along the Y-direction until the contact pins **110** are completely inserted into the respective accommodation portions **132**, as shown in FIG. **7**. Upon the further pressing of the contact pins **110**, the supplementary insulator **150** serves to suitably guide the insertion of the contact pins **110**. Therefore, the supported portions **112** are positioned suitably.

What is claimed is:

1. A connector comprising:

a plurality of contact pins;

an insulator supporting the contact pins in a state arranged in a first direction;

each of the contact pins comprising a supported portion which extends in a second direction perpendicular to the first direction;

the insulator comprising a plurality of accommodation portions which accommodate the respective contact pins, the accommodation portions being arranged in the first direction and extending in the second direction, each of the accommodation portions being provided with a supporting portion which supports the supported portion of the corresponding contact pin, the supporting portion including a supporting surface which receives the supported portion of the corresponding contact pin in a third direction perpendicular to the first and the second directions; and

a supplementary insulator extending in the first direction and fixedly held by the insulator, the supplementary insulator pushing at least one part of the supported portion of each of the contact pins to the supporting surface to hold the at least one part of the supported portion between the supporting surface and the supplementary insulator, and the supplementary insulator being partially fitted within the hole, while being in contact with the supported portions of the contact pins,

the insulator being formed with a hole which extends in the first direction and communicates with the accommodation portions in the third direction.

2. The connector according to claim **1**, wherein: each of the contact pins further comprises a terminal end, a connecting portion and a contact end; the supported portion has two ends; the terminal end is connected to one end of the supported portion; and the connecting portion extends from the other end of the supported portion in a direction oblique to the second and third directions and connects the other end of the supported portion and the contact end.

3. The connector according to claim **1**, wherein each of the supporting portions of the accommodation portions has sidewalls in the first direction, and each of the supported portions of the contact pins is formed with a press-fit portion which is engaged in the sidewall of the supporting portion to fix the supported portion of the contact pin within the supporting portion.

4. The connector according to claim **3**, wherein the press-fit portion is positioned nearer to the terminal end than to the contact end.

5. The connector according to claim **1**, wherein the hole communicates an outside of the insulator with the accommodation portions in the third direction.

6. The connector according to claim **5**, wherein: the supplementary insulator is comprised of a base portion and a plurality of pressing portions; the pressing portions are arranged in the first direction; and each of the pressing portions extends from the base portion in the third direction and is fitted within the corresponding accommodation portion to press at least one part of the supported portion of the corresponding contact pin against the supporting surface of the supporting portion of the corresponding accommodation portion.

7. The connector according to claim **1**, wherein the supplementary insulator is provided with protrusions which are engaged in an inner wall of the hole of the insulator so that the supplementary insulator is partially press-fitted into the insulator.

8. The connector according to claim **1**, wherein each of the accommodation portions has a T-like shaped cross-section in a plane perpendicular to the second direction, and the supporting portion is wider than the other portion of the accommodation portion in the first direction within the cross-section.

9. The connector according to claim **1**, further comprising a shell which surrounds the insulator, the contact pins and the supplementary insulator.

10. The connector according to claim **9**, wherein, the shell is formed with mounting posts for fixing the connector on an object.

11. A fabrication method of the connector according to claim **1**, comprising the steps of:

tentatively inserting the contact pins into the respective accommodation portions along the second direction;

fitting the supplementary insulator to the insulator to press the supported portions against the supporting surfaces of the respective accommodation portions; and

further pressing the contact pins into the respective accommodation portions along the second direction so that the contact pins are completely inserted into the respective accommodation portions.

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